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An Experimental Investigation of the Relationship between the Psychogalvanic Response and the Conscious Intensity of Emotional Response

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AN EXPERIMENTAL INVESTIGATION OF THE RELATIONSHIP BETWEEN THE PSYCHOGALVANIC RESPONSE AND THE CONSCIOUS INTENSITY OF EMOTIONAL RESPONSE

BY

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VITA

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PREFACE

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

The purpose of this study is to examine the relationship between the Psychogalvanic Response (PGR) and the intensity of conscious emotional response. Authors have tended to take extreme positions on this subject. One group (e.g. Koffka, 1935) has held that the relationship _must_ be very close; while another group (e.g. Landis and Hunt, 1935) has held that the relationship is not close.

There have been several experiments that touch, directly or indirectly, on this issue. However, there is almost as much of a difference in reported experimental results as there is in the theoretical discussions. Patterson (1930) reports one correlation figure as low as .33 while Cattell (1929) reports a correlation of 1.00.

There was no work in this area from the time of the Landis and Hunt study (1935) until McCurdy (1950) reviewed the literature and did a short experiment. Again, there has been no work on this problem from 1950 to present.

The theoretical importance of this problem can be easily inferred from the intense theoretical debates that it has evoked. It is probably correct to say that the study of emotion, its physiological correlates, its conscious dimension, the psychophysiological relationships, and the role of learning in respect to these variables is one of the most central problems of psychology.

This is also one of the most difficult areas of psychology. In psychophysics, for example, there was a relatively well defined set of physical variables already in existence. Further, the physicists had already done some elementary work in the area of the subjective correlates of these physical variables. In contrast, in the area of psychophysiology of emotion the physiological variables and psychological variables are simultaneously being defined. This provides the psychologist with the opportunity of contributing to related disciplines as well as receiving help, but it is a more difficult task.

The present study is an attempt to clarify some of the issues in this area. Some advances have been made in the scaling of subjective variables, some advances have been made in the unit of measurement of the PGR. It was hoped that these unit of measurement advances would help to clarify the issue. Also, the present study is based on randomly selected male undergraduates, while most of the previous studies used more sophisticaed Ss. The present study explores individual differences, while most of the previous studies did not (the exception is Dysinger, 1931). Also, the present study explores the possibility of learning taking place. That is, the relationship between PGR and conscious intensity becoming more in agreement as a function of practice.

As a secondary (i.e. not originally planned) finding, some comments on the PGR unit of measurement problem are made in a separate chapter.

CHAPTER II

RELATED LITERATURE

The present study is concerned with the relationship between the conscious emotional intensity and the magnitude of the PGR. Hence, the directly pertinent literature is that which covers the relationship between the variables. There has been much work on the PGR and on scaling taken separately, and there seems no point in duplicating the excellent summaries of the literature which are already available.

General discussions of the PGR are to be found in Landis and DeWick (1929), Landis (1932), Woodworth (1938) and Woodworth and Schlosberg (1954). Discussions of the physiological mechanisms involved are to be found in Darrow (1937) and McCleary (1950). There is also a book summarising a lifetime of research on the human sweating by Kuno (1956) which might be considered if one is interested in the physiological mechanisms. A summary of the literature on the apparatus is found in Thouless (1930). Although since the time of this work much effort has gone into more convenient and more automatic instrumentation, the basic problems remain in about the same status. One recent work on the problems of instrumentation by Bitterman, et all (1954) should be considered. Their general findings tend to indicate that the type of electrode used may not be as significant a factor as had been thought. If one simply changes basal resistance by changing electrodes the responses change in a linear fashion and the relative position of the responses is not changed. The problem of PGR unit of measurement will be considered separately in Chapter V.

The literature on scaling is summarised by Edwards (1957) and Guilford (1954.).

In reviewing the literature on the relationship between the PGR and conscious states one encounters some very strong wording. There has been, as Woodworth and Schlosberg (1954, p. 137) term it, " ... much heated discussion.," concerning the PGR- consciousness relationship. Landis and Jung (1935) refer 'certain psychologists' who do not know when to call one variable a correlate of another variable. The 'certain psychologists' include Wechsler, Ruckmick, Aveling, R.B. Cattell, and Bartlett. Ruckmick (1936, p. 430) states, "...Landis takes his characteristically negative attitude...". Koffka (1935, p. 402) states: "Subjective feeling and objective observation of behavior or of physiological symptoms are in the best possible agreement." This type of heated and sometimes acrimonious atmosphere has undoubtedly impeded understanding in this area. It is hoped that this atmosphere is now in the past.

McCurdy (1950, pp. 322-325) states:

> From the earliest period of PGR experimentation it has been asserted that the magnitude of the galvanometric deflection is intimately related to the subject's estimate of the intensity of his experience- whether emotional, affective, conational, or otherwise. This clear statement has been beclouded by sundry differences of opinion as to the exact quality of experience usually involved; but, so far as the actual evidence goes, there apparently has never been an instance in the literature where the central issue has been in doubt. In spite of this evidential consistency, a number of authors for theoretical reasons have ignored or deprecated the subjective side of the equation; and there are textbooks currently in use which treat the relationship as slight or uncertain, or virtually non-existent...Rare as uniformly positive results are in experimental psychology, one might expect such a relationship as the one brought out in these investigations to be highly valued. Since the study by Dysinger in 1931, I do not know of a single study that treated it as a central topic. This may be accounted for in large measure by the slashing onslaught of Landis on every trace of mentalism in galvanometric work.

McCurdy did an experiment himself, and reviewed the old studies to obtain estimates of the 'correlation' between conscious intensity and PGR magnitude. Because of the way in which much of the older data is presented, McCurdy often had to use a nonparametric estimate of association- the contingency coefficient. McCurdy published a table listing these estimate of 'correlation'. (See Table 1).

Table 1

Correlations between PGR and Experienced
Intensity of Consciousness
Taken from McCurdy (1950)

Study	Correlation Estimate(s)
Starch (1910)	.81
Wells and Forbes (1911)	.93
Wells (1924)	.82
Wechsler (1925)	.59, .67
Sya (1926)	.45
Bartlett (1927)	.78
Cattell (1929)	1.00
Patterson (1930)	.53, .58, .59, .66, .72 .80, .86, .88
Dysinger (1931)	.87
McCurdy (1948)	.76 (corrected, .94)

In interpreting these numbers, one must remember that the contingency coefficient is not directly comparable to any other measure of correlation (Siegel, 1956). Hence, a high corrected C figure argues that some association exists between the variables, but the number is not to be interpreted as though it were a product-moment correlation coefficient.

Landis' position can be seen in a paper written with W. A. Hunt in 1935. The experimenters gave a variety of stimuli (words, questions, tasks, colors, startle stimuli, jokes) to the following subjects: 2 naive Ss; 3 students in advanced psychology; 1 introspectionist; 5 eclectics; 3 psychoanalysts; 4 manic-depressive patients; and 4 dementia praecox patients.

Categories used to describe conscious experiences were supplied by the Ss. They were: effort, inhibition, amusement, startle, uncertainty, tension, intellectualization, confusion, unpleasantness, surprise, pleasantness, relief, wonder, emotion, annoyance, attention, expectation, anticipation, shocked, apprehension, concentration, embarrassment, afraid, scared, unexpected, upset, and miscellaneous. The advantage of having S describe his experience in his own words is that suggestion is avoided. As to the disadvantages, the reader may wonder if 'scared' and 'afraid' really refer to distinct categories of experience. The reader may also wonder if 'scared', 'pleasant', 'unpleasant', etc. should be considered as sub-types of emotion or should be put into non-emotional categories. Landis and Hunt, following the choice of terms used by the Ss, classified them as a distinct type of reaction.

Landis and Hunt conclude: "The results show that the galvanic skin response accompanies all the types of stimuli used and all the types of conscious content reported. Relative quantitative differences do exist, however, and we find emotion consistently high both in number of deflections occurring with it and in size of the deflections. It is suggested that these results be interpreted in terms of the participation of the sympathetic division of the autonomic nervous system." This of course raises and leaves unanswered the question of why the sympathetic nervous system participates more under certain conditions than it does under other conditions.

Landis and Hunt also consider the question of when one variable is to be called a 'correlate' of another variable. They state (p. 507): "If the GSR is a general response, it naturally would give an illusory correlation with conation or emotion if stimuli were used which favored one or the other of these types of reaction...Certain psychologists feel justified in calling the GSR a correlate of some psychological phenomenon if it can be shown to accompany the phenomenon even occasionally. Others feel it must accompany the phenomenon <u>solely</u> and uniformly, if it is to be accepted as a correlate. Certainly the value of any measure as an indicator or practical method depends on the last interpretation."

In the opinion of the present writer, this is a most unfortunate choice of terminology. The term 'correlate' is used with quite a different meaning than the conventional use of the term 'correlation'. Thus, consciousness of emotion and the GSR are not 'correlates', although in the Landis and Hunt data they are 'correlated'.

Further, aside from the confusion arising from the terminology, the criterion of 'indicator or practical method' is to be questioned. At this point it would not seem necessary to defend at length the utility of the concept of correlation. Research workers in general, in psychology and in other fields, have found it extremely useful to express the <u>degree</u> of relationship between variables.

Granted, some of the uses to which the PGR has been naively put can be questioned. For example, Carmena (1935) used the PGR as an index of 'nervousness' and Peterson and Jung (1907) held it to be a 'complex indicator'. However, the solution to this sort of problem is <u>not</u> to abandon the concept of correlation.

The point that Landis and Hunt legitimately make is that the PGR is a general type of response. A few years later (1939), Landis and Hunt demonstrated that these various categories of description might have in common some element of the 'startle pattern'. Woodworth and Schlosberg (1954), after reviewing the PGR literature at length, suggest that the closest description of the conscious states that correspond to the PGR might be that of 'attention'. They point out several close similarities between the PGR literature and the literature on attention.

An examination of some of the other studies would also seem to be indicated. Let us ignore for the moment the earlier studies which were based on a very small number of 'expert' Ss such as Bartlett (one S) Wells and Forbes (two Ss) and Wells (three Ss).

Patterson (1930) touched on the present issue with two experiments. In the first, she used relatively intense stimuli. She threatened to burn S with a match, pointed a pistol at S, informed 3 Ss they had been elected to Sigma Xi, etc. Ss reported very definite body sensations, although not all Ss reported the _same_ sensations. From such cues as the elections to Sigma Xi and the language of the introspections, one gets the impression that these Ss were advanced students. This part of Patterson's work yielded the correlations reported by McCurdy (.53, 158, .59, .66, .72, .80, .86, .88). In the second part of her study, 21 Ss 'with varying degrees of training in psychology' yielded a correlation of .33. The difference between the figures obtained in the two parts of her study suggest that perhaps the type of S is important. Also, the presence of body sensations may be important.

Dysinger (1931) compared the PGRs to words with the subjective rating of pleasantness or unpleasantness. His Ss were six graduate psychology students, four undergraduate psychology students, and three undergraduates with no psychology training. All but one of the Ss had three trials of 50 words each. They used the following rating categories: very pleasant, pleasant, indifferent, unpleasant, and very unpleasant. Dysinger found that the PGR tends to increase with ratings of both pleasant and unpleasant, and increases more with ratings of very pleasant or very unpleasant.

Dysinger used a rather strict criterion of correspondence. If, on a given trial, a S's mean PGRs increased without exception as the ratings increased, the trial was judged to be one of correspondence. However, if there was an exception, such as the mean PGR to pleasant and very pleasant being equal, Dysinger judged the trial as a lack of correspondence. Using this criterion, Dysinger rated 25 trials as showing correspondence and 12 trials as showing a lack of correspondence. McCurdy (1950) interprets this in terms of a corrected C of .87. Again, one must remember that a contingency coefficient is not to be interpreted as though it were a product-moment correlation.

Dysinger's tables permit further analysis than was done by either Dysinger or McCurdy. The graduate students can be compared with the undergraduate students, and the first trial can be compared with succeeding trials.

In comparing graduate students with undergraduate students, one finds that the graduate students met Dysinger's criterion of correspondence in 16 trials and failed to meet this criterion in 2 trials; the undergraduate psychology students met the criterion in 5 trials and failed to meet it in 5 trials; and the undergraduate students with no psychology training met the criterion in 4 trials and failed to meet the criterion in 5 trials. Despite the strictness of

Dysinger's criterion, let us assume that the probability of success is .5 and the probability of failure is .5. Using the binomial equation, the probability of 16 successes out of 18 trials (graduate students) is.001. But the probability of 5 successes and 5 failures or 4 successes and 5 failures (undergraduates) can be obviously explained by chance.

When the comparison is made by trials, it is found that in the first trial Dysinger's criterion of correspondence was met 7 times and was not met 6 times; in the second trial his criterion was met 9 times and was not met 3 times; and in the third trial, his criterion was met 9 times and was not met 3 times. Again using the assumption that the probability of success is .5, it is found that the probability of 7 successes in 13 trials is .5; the probability of 9 successes in 12 trials is .07; and if the second and third trials are combined, the probability of 18 successes in 24 trials is .01.

Thus, Dysinger's data would clearly indicate that his graduate students could give more cases of correspondence than chance could explain (under the p. is .5 and q is .5 assumption, which is an extremely strict test); while his undergraduate Ss could not show a better than chance correspondence. Dysinger's data also suggest that possibly there is an improvement with practice, although this point is not as clearly shown as is the graduate-undergraduate distinction.

In the opinion of the present writer, these points are of great interest. Throughout the PGR literature, from Peterson and Jung (1907) and Veraguth (1908) to woodworth and Schlosberg (1954), one finds the term 'psychophysics' used in very vague and analogous ways. The psychophysics analogy may be very useful, but it may also be misleading if one is not aware that he is using an analogy which may or may not apply. If workers in the consciousness-PGR area had the psychophysics analogy in mind, this would explain in part why they failed to notice such things as differences between different types of Ss and indications that some sort of learning may be taking place. If they were using classical psychophysics models workers would not expect or look for or even notice phenomena associated with learning or the more recent perceptual learning models. And if there are learning or perceptual-learning phenomena occurring, this would help to explain how one experimenter can report a correlation of 1.00 while another experimenter reports a correlation of .33.

CHAPTER III

PROCEDURE

The present study attempts to answer the following questions. (1) How closely are PGR amplitude and conscious emotional intensity related for randomly selected male undergraduates? (2) How much does this closeness of relationship differ from one student to another? and (3) Is there any indication that this relationship becomes more close as a function of practice?

From this statement of the problem, it would seem that the logical procedure would be: (1) select stimuli; (2) show the stimuli to a number of randomly selected male undergraduates, making a record of the magnitude of the PGRs and of the ratings of subjective intensity, giving each S at least two trials, the stimuli being counterbalanced; (3) estimate the closeness of the relationship between the variables for the 'average' S; (4) make estimates of the closeness of this relationship for each S; and (5) see if Ss tend to give closer relationships between these variables on the second trial than they did on the first trial.

The experimenter had some doubts about looking for learning on only two trials. However, to increase the number of trials would tend to force E to use fewer Ss, which would make it difficult to sample individual differences. The two-trial procedure was chosen because of Dysinger's results (1931) which indicate that there might be a change from the first trial to the second trial but not from the second trial to the third trial. If approximately the same proportion of improvement holds as the number of Ss is enlarged, there would be a rather clear indication of some sort of learning.

Selection of Stimuli

For rather obvious reasons, the evoking of genuine and strong emotional responses in a laboratory situation involves practical difficulties. The traditional PGR experiment has used free assocation words as stimuli. As Woodworth and Schlosberg point out, however, the typical college student subject tends to give a rather superficial type of assocation. One may question, therefore, how genuinely the Ss are experiensing personal emotional involvement. Some experimenters, such as Ax (1953) have worked out very clever experiments to get one or two genuine and strong emotional reactions from their Ss. These one or two reaction techniques would seem to be of little help in this problem. Others have tried to get more than one or two reactions by having Ss do a series of things (e.g., cut the head off a frog). However, since we know that movements, deep breathing, sensations, etc. evoke PGRs quite apart from any emotion involved, this sort of data is ambiguous at best.

It seemed that perhaps the candid photographs that appear in such magasines as Life might make good stimuli. They would not be as 'real' as the actual experience, or perhaps as 'real' as motion pictures, but would seem to be better than free-association words.

Pilot Study

To answer these questions, an empirical approach seemed necessary. So a number of pictures were selected, and appropriate titles were made for these pictures. Slides were made of 25 of the pictures alone, 25 slides of the titles alone, and 25 slides of the pictures and titles together. (See Appendix I). These stimuli were presented to 100 male undergraduate students, who were asked to rate how strong an emotion they evoked. The order of the presentation of the stimuli was partially counterbalanced. Calling pictures alone 'A', titles alone condition 'B', and pictures with titles condition 'C'; 17 _Ss_ received order ABC, 17 _Ss_ received order ACB, 17 _Ss_ received order BAC, 17 _Ss_ received order BCA, 17 _Ss_ received order CAB, and 15 _Ss_ received order CBA.

_Ss_ were asked to indicate their ratings on a nine-point successive interval scale. (See Appendices II and III). Cummulative proportions were counted and these were plotted on normal probability graphs. The values of the medians and inter-quartile ranges were read from the graphs. It might be noted that the distributions of the raw (not 'normalized') scores for the stimuli fit a 'normal' distribution remarkably well.

As seen in Tables 2 and 3, both pictures with titles and pictures alone evoked significantly higher (.05) ratings than did titles alone. Pictures with titles had higher medians than the titles alone in 19 of the 25 cases. Using the sign test as described by Siegel (1956), one finds the probability of 19 out of 25 cases to be approximately .002. Pictures alone had higher medians than titles alone in 16 of the 25 cases, lower medians in 7 of the 25 cases, and equal medians in 2 of the 25 cases. The sign test yields a probability of approximately .047.

However in the case of pictures with titles compared with pictures alone, there is no significant difference. Pictures with titles have higher medians

Table 2

Median Emotional Intensity Ratings Given By 100 Male Undergraduates to 25 Pictures with Titles, the 25 Pictures Alone, and the 25 Titles Alone

Stimulus	Picture with Title	Picture Alone	Title Alone
1	3.8	3.4	3.8
2	3.7	3.4	3.3
3	5.0	4.9	4.7
4	4.1	4.4	3.6
5	4.1	3.5	4.2
6	4.0	4.2	4.5
7	4.0	4.4	4.0
8	4.9	4.1	4.2
9	4.7	5.0	4.6
10	4.3	4.8	4.2
11	4.6	4.2	3.8
12	4.3	4.0	4.0
13	4.6	4.1	4.6
14	4.0	4.0	3.5
15	3.8	4.0	3.6
16	4.4	3.8	4.1
17	5.2	4.8	5.3
18	4.8	5.0	4.5
19	4.3	4.3	3.9
20	5.2	5.3	4.3
21	5.0	4.7	4.7
22	3.3	3.1	2.6
23	4.3	4.2	3.9
24	4.5	4.9	4.4
25	4.3	4.3	4.0

Table 3

Comparisons between Median Emotional Intensity Ratings Given by 100 Male Undergraduates to 25 Pictures with Titles, the 25 Pictures Alone, and the 25 Titles Alone

Stimulus	Pictures with Titles Versus Pictures Alone	Pictures with Titles Versus Titles Alone	Pictures Alone Versus Titles Alone
1	+	=	-
2	+	+	+
3	+	+	+
4	-	+	+
5	+	-	-
6	-	-	-
7	-	=	+
8	+	+	-
9	-	+	+
10	-	+	+
11	+	+	+
12	+	+	=
13	+	=	-
14	=	+	+
15	-	+	+
16	+	+	-
17	+	+	-
18	-	+	+
19	=	+	+
20	-	+	+
21	+	+	=
22	+	+	+
23	+	+	+
24	-	+	+
25	=	+	+
	+ is 13 - is 9 = is 3	+ is 19 - is 3 = is 3	+ is 16 - is 7 = is 2

Table 4

Dispersion (Q) of Emotional Intensity Ratings Given
by 100 Male Undergraduates to 25 Pictures
with Titles, the 25 Pictures Alone,
and the 25 Titles Alone

Stimulus	Picture with Title	Picture Alone	Title Alone
1	1.2	1.3	1.2
2	1.2	1.0	1.2
3	1.2	1.2	1.4
4	1.2	1.1	1.4
5	1.1	1.2	1.2
6	1.4	1.3	1.4
7	1.3	1.2	1.3
8	1.2	1.2	1.2
9	1.2	1.1	1.2
10	1.4	1.1	1.4
11	1.3	1.4	1.3
12	1.0	1.1	1.0
13	1.1	1.0	1.1
14	1.0	1.0	1.0
15	1.1	1.2	1.2
16	1.3	1.3	1.4
17	1.4	1.2	1.4
18	1.2	1.5	1.2
19	1.1	1.2	1.2
20	1.2	1.4	1.2
21	1.1	1.1	1.2
22	1.3	1.2	1.1
23	1.3	1.2	1.2
24	1.1	1.2	1.0
25	1.0	1.2	1.0

Table 5

Comparisons between Dispersions (Q) of Emotional Intensity Ratings Given by 100 Male Undergraduates to 25 Pictures with Titles, the 25 Pictures Alone, and the 25 Titles Alone

Stimulus	Pictures with Titles Versus Pictures Alone	Pictures with Titles Versus Titles Alone	Pictures Alone Versus Titles Alone
1	-	=	+
2	+	=	-
3	=	-	-
4	+	-	-
5	-	-	=
6	+	=	-
7	+	=	-
8	-	=	=
9	+	=	-
10	+	=	-
11	-	=	+
12	-	=	+
13	+	=	-
14	=	=	=
15	-	-	=
16	=	-	-
17	+	=	-
18	-	=	+
19	-	-	=
20	-	=	+
21	=	-	-
22	+	+	+
23	+	+	=
24	-	+	+
25	-	=	+
	+ is 10 - is 10 = is 5	+ is 3 - is 7 = is 15	+ is 8 - is 11 = is 6

than pictures alone in 13 of the 25 cases, lower medians in 9 of the 25 cases, and equal medians in 3 of the 25 cases. The sign test yields a probability of greater than .10.

As seen in Tables 4 and 5, the different types of stimuli did not yield significantly (.05) different dispersions of ratings. Pictures with titles yielded higher inter quartile ranges than did pictures alone in 10 of the 25 cases, lower in 10 of 25 cases, and equal in 5 of 25 cases. Again using the sign test, the probability is greater than .10. Pictures with titles yielded higher inter quartile ranges than did titles alone in 3 of 25 cases, lower in 7 of 25 cases, and equal in 15 of 25 cases. Again, the probability is greater than .10. Pictures alone yielded higher inter-quartile ranges than did titles alone in 8 of 25 cases, lower in 6 of 25 cases, and equal in 11 of 25 cases. Again, the probability is greater than .10.

Since the purpose is to find stimuli that will evoke relatively strong emotional experiences, and be realistic; either pictures with titles or pictures alone would seem preferable to titles alone. However, there is no basis, either in magnitude of ratings or in dispersion of ratings, for choosing between pictures with titles or pictures alone. Pictures with titles were used in the experiment, although pictures alone could also have been used. After all this has been done, the present writer is not satisfied that the problem has really been solved. The stimuli are probably better than the traditional free-association words, but they are not the same as the situations themselves.

Subjects

Subjects were randomly selected male undergraduate students. The study was limited to male subjects, because it was thought that female Ss might react differently to some of the stimuli. Also, there might be a difference in the correlation figures obtained from male and female Ss. If one examines the studies which form the basis for McCurdy's table, it seems that those studies which report relatively high correlations, such as McCurdy (1950) and Wechsler (1925) used female Ss; while the lower figures, such as Syz (1926) are based on male Ss. Now this is not the only difference in the experiments; experimenters, stimuli, instruments, and situations also differed. But it was decided that it would be better to over control than to fail to control for a variable that might be important.

Experimental Situation

A final selection of 50 stimuli was made. (See Appendix IV). Each of the 50 Ss was shown the 50 stimuli; 25 on the first day and the other 25 on the second day. The stimuli were partially counterbalanced. Calling slides 1-10 'series A', slides 11-20 'series B', slides 21-30 'series C', slides 31-40 'series D', and slides 41-50 'series E'; the series were counterbalanced, but the place of a slide in its series was constant. This particular form of partial counterbalancing was used because, in the first place it would be impossible to completely counterbalance 50 stimuli in 50 trials; so some form of partial counterbalancing was necessary. Secondly, in choosing one form of partial counterbalancing over another; it was believed that if the place of the slide in the series were altered, some Ss would receive a succession of slides relating to the same general subject or possibly even a meaningful series of slides.

Each S was asked to rate the intensity of his subjective emotional reaction to each slide immediately after the presentation of the stimulus by saying a number from one to nine, with one being the least strong and nine being the most strong. (See Appendix V). Each S had at least five practice stimuli to insure that he understood the instructions and in a few cases where there was some misunderstanding the Ss received five more practice stimuli.

The stimuli were presented on 35 m.m. slides, which were projected on a screen. This method of presentation can give relatively large images. However, if the experimental room is small, as in this case, a short focal length lens must be used. In this experiment, a Bell and Howell "Headliner" semi-automatic projector was used with a 3 inch lens. The chief advantage of this method of presentation is that the S is not required to handle anything, which would result in PGRs due to muscle movement; and the experimenter (who already has to record ratings and handle the PGR apparatus) does not have to worry about trying to keep 50 stimuli in their proper sequence.

A continuous photographic recording was made of the skin resistance. The galvanometer was a constant-current, critically damped, Wheatstone bridge type which follows the design described by Woodworth (1938). For a further description of the apparatus, see Flanagan and Herr (1959).

CHAPTER IV

ANALYSIS OF RESULTS - RATING SCALES AND RELATIONSHIP
BETWEEN PGR AND RATING

Rating Scales

Each S rated each stimulus by saying a number between 1 and 9. He did this immediately after the presentation of the stimulus. This rating is used in two ways: first, in the determination of the scale values of the stimuli for comparison with the average PGRs evoked by the stimuli; secondly, the ratings and PGR values were compared within each S.

The scale values of the stimuli were computed in two ways: by the successive interval method described by Edwards (1957), which assumes that the discriminal dispersions are equal; and by the method of Rimoldi and Hormaeche (1955) which does not assume that the discriminal dispersions are equal. In the case of the Rimoldi and Hormaeche method, the missing normal deviates of extreme categories were extrapolated graphically by plotting the known normal deviates of the stimulus against the average normal deviates of all the other stimuli. This extrapolation procedure is described by Devane and Rimoldi (1960). The scale values obtained by these two methods are given in Tables 6 and 7. The values obtained by these methods are in close agreement, having a product-moment correlation of .96.

Table 6

Relative Subjective Intensities of 50 Pictures with Titles (Appendix IV) Based on Ratings by 50 Experimental Subjects and Scaled by Method of Successive Intervals as Described by Edwards (1957)

Stimulus	Scale Value	Stimulus	Scale Value
1	2.04	26	2.34
2	2.04	27	1.87
3	2.78	28	2.40
4	2.23	29	2.12
5	2.37	30	1.87
6	2.41	31	2.94
7	2.50	32	3.06
8	2.56	33	3.29
9	1.95	34	2.79
10	2.25	35	2.19
11	1.79	36	1.51
12	2.45	37	2.24
13	1.66	38	2.53
14	2.82	39	2.93
15	1.14	40	1.36
16	2.59	41	2.64
17	2.11	42	1.94
18	2.51	43	2.79
19	1.91	44	2.19
20	2.23	45	2.19
21	2.54	46	2.37
22	1.96	47	2.96
23	2.33	48	1.85
24	1.44	49	1.66
25	2.41	50	2.78

Table 7

Relative Subjective Intensities of 50 Pictures with Titles (Appendix IV) Based on Ratings by 50 Experimental Subjects and Scaled by Method of Successive Intervals as Described by Rimoldi and Hormaeche (1955)

Stimulus	Scale Value	Stimulus	Scale Value
1	1.65	26	1.94
2	1.58	27	1.55
3	2.37	28	2.27
4	1.80	29	1.97
5	2.00	30	1.68
6	2.04	31	2.62
7	2.07	32	2.67
8	2.34	33	2.79
9	1.92	34	2.56
10	1.72	35	2.02
11	1.63	36	1.40
12	2.27	37	1.92
13	1.60	38	2.24
14	2.33	39	2.47
15	1.14	40	1.32
16	2.30	41	2.38
17	2.06	42	1.63
18	2.20	43	2.44
19	1.60	44	1.86
20	1.87	45	2.15
21	2.21	46	1.86
22	1.74	47	2.66
23	1.85	48	1.71
24	1.19	49	1.64
25	2.18	50	2.57

Besides comparing the results of one method of scaling with the results of another method of scaling, one can indirectly check the adequacy of the scaling procedure by using the scale values to attempt to reproduce the empirical data. If the assumptions that have been made in scaling the data are tenable, the reproduced data should agree with the original data. The absolute average error can then be computed. The average error between reproduced values and the empirical data is .028 in the case of the scaling technique described by Edwards; and is .022 in the case of the scaling technique described by Rimoldi and Hormaeche. Considering that these scale values are based on 50 Ss, these figures compare favorably with the average errors reported by other studies. For example, Edwards (1957) reported an average error of .024 with 200 Ss; Edwards and Thurstone (1952) reported an average error of .025 with 253 Ss; and Edwards (1952) reported an average error of .021 with 133 Ss.

The effect of serial position on PGR scores will be discussed in Chapter V. The possible effect of serial position on rating was also explored. Many workers counterbalance stimuli to be rated in an effort to eliminate possible serial effects. In this study, as was discussed previously, the stimuli were partially counterbalanced. That is, calling stimuli 1 - 10 'series A', Stimuli 11-20 'series B', etc.; the <u>series</u> were counterbalanced, but the place of a stimulus in the series was constant. There remained the question of whether there is, in fact, a serial effect actually present in the data. The product-moment correlation between ratings and position is -.02 for this data.

This does not mean that there <u>cannot</u> be a position effect in a particular set of data. It will be recalled that in assigning a stimulus to a place in a series, great care was used to avoid meaningful sequences, etc. If this had not been done, the results might be quite different. Or if Ss had been instructed differently, the results might be different. However, these results would tend to indicate that position effects in a set of data would be due to some systematic arrangement of stimuli or instructions, and not to position per se.

PGR-Rating Relationship - General Considerations

In considering the relationship between the PGRs and ratings, it should be remembered that the stimuli involved are of a symbolic nature, and that the PGRs are of a corresponding magnitude, the average PGRs given to the stimuli ranging from approximately 2 to 5 per cent of the basal resistances.

In discussing the size of correlations, comparisons are legitimate only if, among other things, the 'ranges of talent' are comparable. Hence, it would not be legitimate to generalise from the results of this study to the case where 'real life' stimuli would be involved, and the changes might have a range in the order of 20 or 20 per cent of the basal resistance.

Ss were asked how they arrived at the ratings they reported. The Ss all stated that ratings were not based on body sensations. Ss sometimes stated that they were aware of body sensations in the cases of one or two stimuli, but not in the cases of the other 48 or 49 stimuli. Many Ss said that they were not aware of body sensations at any time. Hence, 'real life' stimuli not only offer a greater 'range of talent' but also provide additional cues.

In attempting to describe how the ratings were arrived at, Ss described what appear to be two different methods. Some used terms such as 'vividness', 'interesting' or 'surprising' to describe the basis of the ratings. Others described some sort of a process of analogy, saying something to the effect:

"I estimated how I thought I would react _if_ I were really confronted with the situation".

This 'How I would react' system seemed to be based largely on the pleasantness or unpleasantness of the situation depicted. The system of how 'interesting' or 'vivid' the stimuli seemed was apparently based on several factors, including such things as 'I have a friend who did this' and the purely graphic qualities of the stimulus.

No attempt was made to compare the results of these methods; because appropriate controls were not incorporated in the design of the experiment and many Ss reported using both methods. Those Ss who reported only one method may well have occasionally used the other method.

PGR-Rating Relationship - Scale Values of Stimuli Compared to Average PGRs of Stimuli

In comparing the scale values of the stimuli with the average PGRs to the stimuli, the following results were obtained. The average PGR to each stimulus was computed by means of ohms change and by means of the Haggard Score, a transformed PGR measure to be discussed in Chapter V. The PGR values of the stimuli are presented in Tables 8 and 9.

Using scale values determined by the method described by Edwards (1957), which assumes that the discriminal dispersions are all equal, the produce-moment correlation with PGR measured in ohms change is .25 and with PGR measured in Haggard Scores is .25. Using scale values determined by the method of Rimoldi and Hormaeche (1955), which does not assume that all the discriminal dispersions are equal, the product-moment correlation with the average PGR measured in ohms change is .18 and with PGR measured in Haggard Scores is .20. A typical plot of this relationship is presented in Fig. 1.

In examining the plotted relationship, the experimenter noticed that the stimuli which occurred in the first part of a series appear (visually) to give a poorer 'fit' than do the stimuli which occur later in the series. To illustrate this, the first three stimuli in each series are presented as circles, and the last seven stimuli in each series are presented as squares in Fig. 1.

The correlations were computed again, using only the last seven stimuli in each series, and calling the first three stimuli 'practice stimuli', a type of procedure that many PGR workers have used. The correlation between scale values by the Edwards method and ohms change went from .25 to .30; between Edwards method scale values and Haggard scores from .25 to .30; between Rimoldi method scale values and ohms change from .18 to .33; and between Rimoldi method scale values and Haggard scores from .20 to .34.

In so far as the present writer is aware, these figures are among the lowest ever reported, being comparable only to part of Patterson's (1931) study, which resulted in a correlation of .33.

PGR-Rating Relationship - Intraindividual Comparisons

The results were further analysed in terms of correlation ratios between ratings and PGRs within the individual Ss. These were further analyzed in terms of first day, second day, and all stimuli combined. See Table 10 and Fig. 2. It must be remembered that these figures represent correlation ratios, and not Pearson correlations. Eta was chosen to avoid the need for scaling the judgments within each S. If the data is assumed to represent equal intervals,

Table 8

Average PGRs in Ohms* Units Given to 50 Pictures

With Titles (Appendix IV) by 50 Subjects

Stimulus	Average Change	Stimulus	Average Change
1	32	26	22
2	22	27	23
3	17	28	20
4	19	29	21
5	19	30	15
6	29	31	30
7	19	32	31
8	17	33	20
9	20	34	27
10	17	35	20
11	28	36	17
12	21	37	15
13	19	38	19
14	24	39	18
15	19	40	16
16	23	41	29
17	19	42	26
18	17	43	19
19	19	44	24
20	17	45	15
21	30	46	24
22	22	47	24
23	40	48	18
24	17	49	20
25	20	50	18

* Unit corresponds to 1 m.m. deflection and equals 22.74 ohms.

Table 9

Average PGRs in Haggard Scores* Given to 50 Pictures

With Titles (Appendix IV) by 50 Subjects

Stimulus	Average Haggard Score	Stimulus	Average Haggard Score
1	575	26	513
2	499	27	516
3	430	28	504
4	446	29	533
5	467	30	442
6	532	31	544
7	457	32	600
8	455	33	488
9	460	34	574
10	416	35	541
11	505	36	447
12	499	37	419
13	486	38	505
14	552	39	496
15	502	40	454
16	533	41	568
17	484	42	548
18	475	43	498
19	489	44	550
20	442	45	439
21	595	46	523
22	502	47	552
23	686	48	539
24	477	49	526
25	502	50	514

* A transformed PGR unit of measurement discussed in Chapter V.

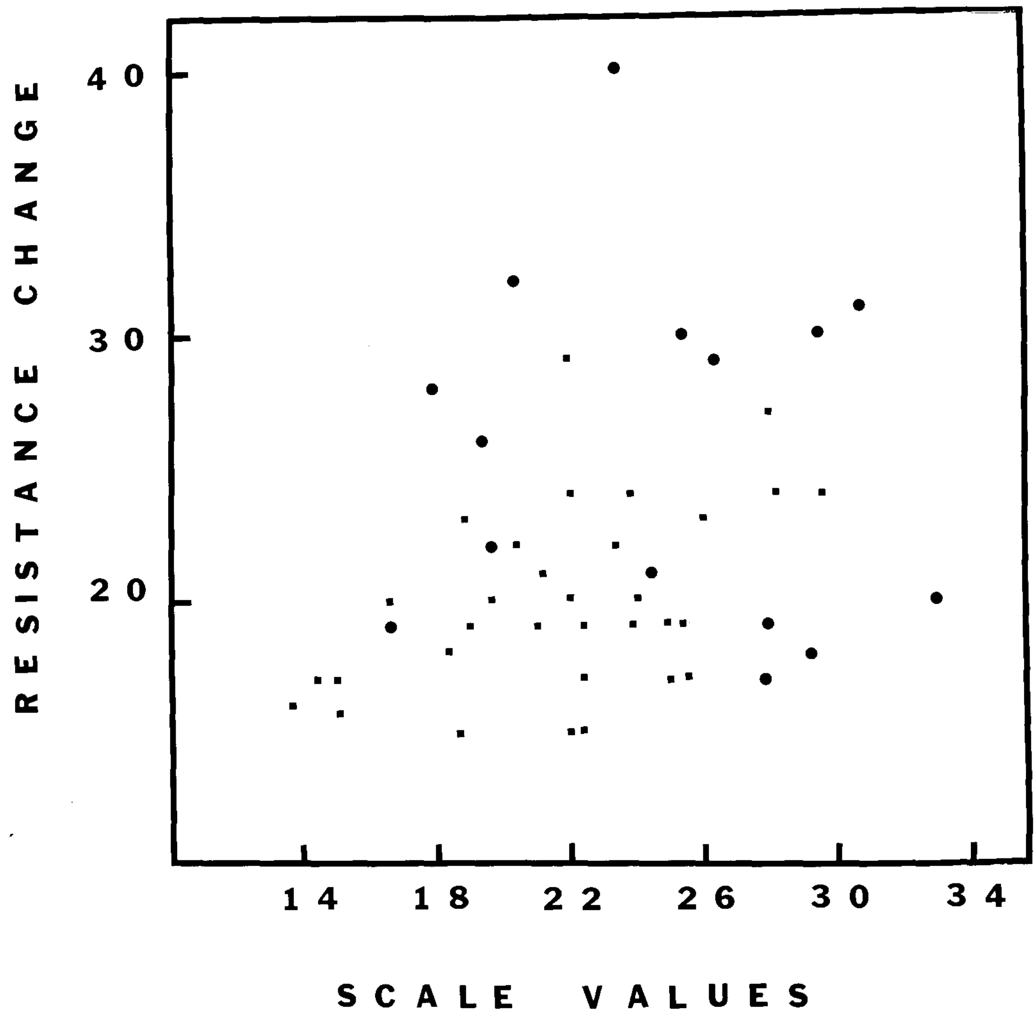


Figure 1

Relationship between Subjective Intensity

And Average PGRs of 50 Subjects to 50 Pictures

With Titles (Appendix IV) First Three Stimuli in Each

Series Express as Circles, Last Seven Expressed as Squares the resulting values are not linearly related to the values obtained by the method of paired comparisons or successive intervals (Edwards, 1957). On the other hand, an empirical check of ten per cent of the Ss indicates that the correlation ratios do not differ significantly (.05) from r values. Hence, these eta values are probably high estimates of the degree of relationship present.

Three points emerge rather clearly from this analysis. (1) There is a tendency for the correlation ratios to increase from the first day to the second day. (2) There is a wide range in the correlation values obtained, one being as low as .05, and another being as high as .90. (3) The assumptions of the mental measurement model, such as those involved in the attenuation of correlations, are not being met. By combining the items from the first day and second day within each S, a <u>decrease</u> in the correlation values was obtained more often than an <u>increase</u>. In most cases, the combined figure was neither higher nor lower; but if combining the data had any influence, it tended to decrease more often than to increase the correlation.

Concerning the first point, since previous data indicated that <u>perhaps</u> there is a change from session to session in the ability of Ss to make the two measures agree, this experiment consisted in Ss receiving one-half of the stimuli on one day, and the other half on the succeeding day. The series of stimuli were counterbalanced. In 36 cases, the correlation ratios increased from the first day to the second day; in 14 cases the correlation ratios were equal or decreased. The one case of equality was treated as a decrease. Assuming that by chance .5 of the cases should increase and .5 of the cases should decrease, one would expect 25 increases and 25 decreases. The standard

Table 10

Correlation Ratios between PGRs and Ratings

Within Individuals for First Day

(25 Stimuli), Second Day

(Another 25 Stimuli), and

Both Days Combined

Subject	Eta First Day	Eta Second Day	Eta All Stimuli	Direction of Change in Eta
1	.40	.76	.56	+
2	.50	.38	.37	-
3	.44	.48	.34	+
4	.20	.67	.51	+
5	.55	.78	.65	+
6	.62	.70	.45	+
7	.67	.50	.49	-
8	.48	.34	.36	-
9	.36	.69	.38	+
10	.51	.45	.34	-
11	.38	.38	.38	-
12	.58	.48	.28	-
13	.45	.52	.55	+
14	.43	.85	.33	+
15	.19	.44	.41	+
16	.41	.64	.43	+
17	.49	.57	.48	+
18	.39	.71	.47	+
19	.68	.84	.73	+
20	.32	.63	.47	+
21	.28	.50	.41	+
22	.50	.62	.51	+
23	.40	.83	.60	+
24	.37	.15	.20	-
25	.42	.73	.41	

(Continued)

Table 10 (Continued)

Correlation Ratios between PGRs and Ratings Within Individuals for First Day (25 Stimuli), Second Day (Another 25 Stimuli), And Both Days Combined

Subject	Eta First Day	Eta Second Day	Eta All Stimuli	Direction of Change in Eta
26	.25	.59	.29	+
27	.49	.57	.40	+
28	.36	.48	.46	+
29	.53	.05	.26	-
30	.35	.37	.35	+
31	.22	.42	.25	+
32	.35	.37	.32	+
33	.40	.38	.32	-
34	.58	.68	.64	+
35	.15	.51	.20	+
36	.42	.39	.45	-
37	.46	.50	.48	+
38	.51	.79	.31	+
39	.47	.46	.28	-
40	.43	.35	.41	-
41	.56	.90	.55	+
42	.24	.71	.31	+
43	.54	.59	.44	+
44	.34	.54	.39	+
45	.32	.61	.45	+
46	.50	.72	.43	+
47	.18	.44	.25	+
48	.58	.52	.34	-
49	.47	.50	.43	+
50	.32	.32	.17	-

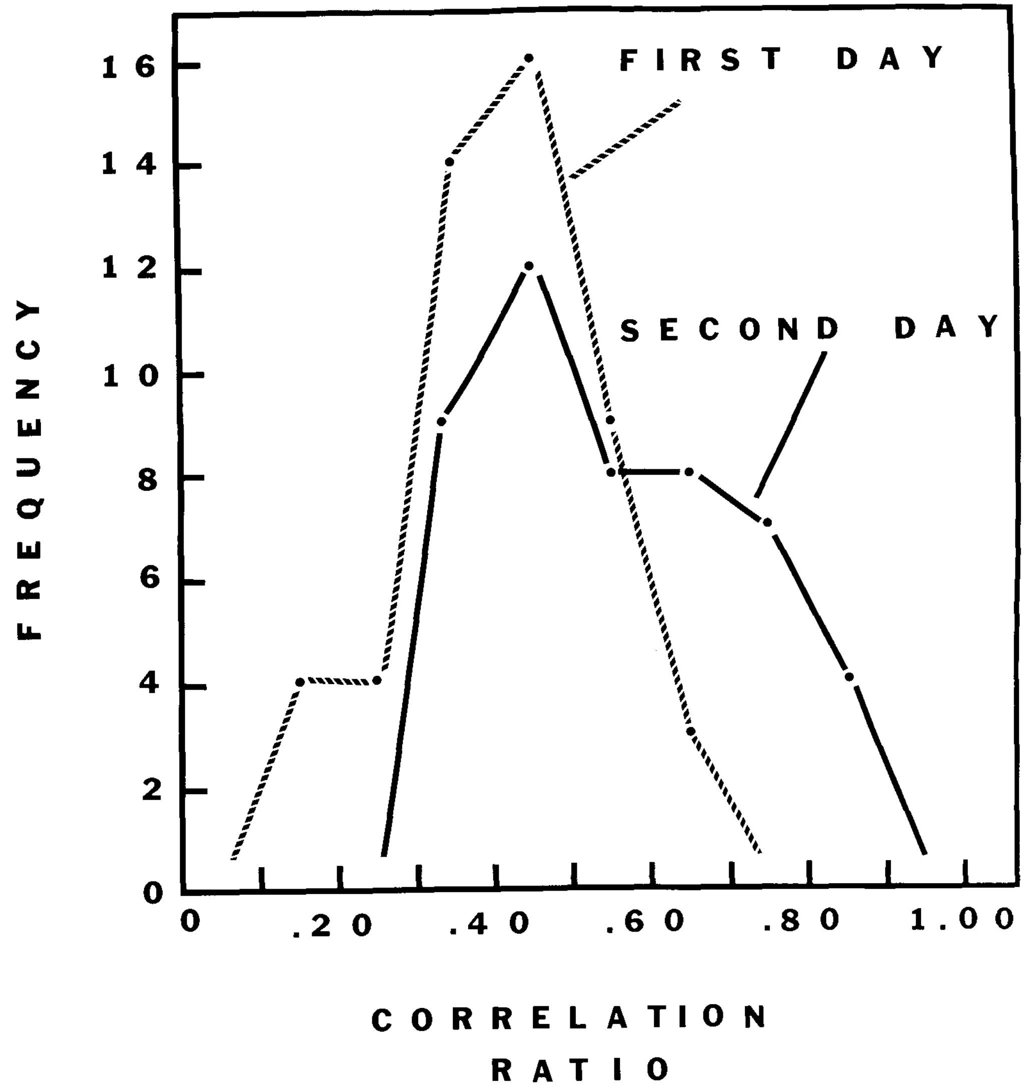


Figure 2

Frequency Distributions

Of Intraindividual Correlation

Ratios within 50 Ss for 50 Pictures

With Title, 25 Stimuli Given on One Day

And the Other 25 Stimuli Given on Succeeding Day deviation would be $\sqrt{NPQ}$ or 3.53. Hence, the obtained result of 36 increases and 14 decreases represents a difference of 11 cases from the expected 25 increases and 25 decreases; or, expressed in terms of the standard deviation with a correction for continuity it represents a difference of 10.5/ 3.53 from chance expectancy. The probability of obtaining a difference of 2.97 standard deviations from the expected values is less than .002.

The second point, that there is a great range of eta values is self explanatory. However, the information needed to make this statement had not previously been collected. It remains to be seen whether any practical use can be made of this individual difference. However, the magnitude of the range, from a correlation of .05 to one of .90, was somewhat unexpected, and interesting for the study of individual differences.

The third point, that combining data for both days for each S is more likely to lower the correlation figure than to increase it is again an empirical statement that may or may not prove useful. Theoretically, it indicates that this problem does not meet the various assumptions (see Gulliksen, 1950, P. 98) of the mental measurement model. This model has been used by at least one author (McCurdy) for the attenuation of the obtained PGR-consciousness correlation. However, in distinction to the classical psychophysics model, which has been widely used for PGR work, the mental measurement model has not been widely used.

If one examines Table 10, it is observed that in 20 cases the combined data yields correlation ratios that are lower than the correlation ratios within either of the parts; in 28 cases the combined figure is neither higher nor lower than the correlations within the parts; and in only 2 cases is the combined figure higher than that within both of the parts. If it is assumed that the probability of higher is .5 and the probability of lower is .5, and use the binomial equation (Siegel, 1956) it is determined that the probability of 20 cases lower and 2 cases higher is less than .001.

General Discussion

The following discussion is not an attempt to do any rigorous testing of hypotheses, but is merely an attempt to discover what variables might be pertinent. Despite the fact that the problem has been discussed in the literature for many years, we do not know what variables are pertinent, and should be controlled, as opposed to those variables that are not pertinent, and need not be controlled.

The present writer is inclined to interpret the relatively low over-all rating-PGR correlation in terms of either differences in Ss or some sort of practice effect. There is evidence that these variables could influence the results. The present study indicates that some sort of practice effects can influence the results. A reanalysis of Dysinger's data indicates that a difference in Ss (graduate or undergraduate) can influence the results. On the other hand, such differences as scaling techniques and PGR units of measurement did not greatly change the results in the present study. Further, authors (Edwards, 1957 and Guilford, 1954) have shown that the various scaling techniques tend to correlate quite highly with one another and the various PGR units of measurement tend to correlate quite highly with one another (Hunt, W.A., and Hunt, E.B., 1935).

Practice effects would seem to be the less probable explanation, for it would seem that authors would have reported any special training they gave the Ss. They do not mention any training or practice beyond the usual procedures to ensure that the Ss understand the task.

On the other hand, there seems to be a general correspondence between the magnitude of the correlations reported and an 'arm-chair' evaluation of the probable psychological sophistication of the Ss used (undergraduates, then graduate and professional students, then specially trained introspectionists). The undergraduates used in this study and in Patterson's study (second part) yielded the lowest figures (.20-.34); Syz's freshman medical students yielded a higher figure (.45); Weschler's graduate students of social work (female) and Patterson's advanced Ss (first part of study) yielded higher figures (.53 to .88); and the studies which used a small number of introspectionists (Bartlett, Cattell, Starch, Wells, and Wells and Forbes) yielded the highest figures (.78 to 1.00). The study by Dysinger showed that his graduate Ss clearly met his criterion of agreement while his undergraduate Ss did not. The one exception to this pattern is the study by McCurdy which reports a higher figure for female undergraduates than Weschler reports for female social work students.

If the Intraindividual PGR-rating correlation increases from the first session to the second session, one is tempted to speculate on why it changed. Two explanations suggest themselves. That there is some sort of learning taking place, or that the increase occurs because of the adaptation effect in the PGR. The PGR consistently shows a curvilinear decrease from the beginning of a session to the end; this has been reported in study after study. There is no doubt that the relationship exists, but there has been no literature on the magnitude of the correlation between series position and PGR. In this study a correlation ratio was computed between the serial position and PGR and was .30. If eta is used as an estimate of the r that would be obtained if the PGR data were transformed to eliminate serial effect, the rationale of partial correlation (Guilford, 1950) can be used to estimate what would happen to the PGR-rating correlation with the PGR-position correlation eliminated. Since the correlation between rating and position is practically zero (.02) the elimination of the PGR-position correlation of .30 would have very little effect on the PGR-rating correlation. It would change a correlation of .25 to one of .26. Hence, the explanation that there is some sort of learning taking place would seem the more plausible one.

The term 'learning' can mean a general, relatively permanent type of change or it can mean a specific change or adaptation to the experimental situation. There is no basis for a crucial decision as to whether this change is general or specific. However, the present author is impressed by the cummulative indications that a general type of change is taking place. That is, while such things as graduate Ss compared to undergraduate Ss, change from session one to session two, an apparent relationship between psychological sophistication of Ss and correlations obtained, etc. do not provide a basis for a crucial decision, the indications all point in the same direction.

Be that as it may, there is clearly some sort of change occurring as a function of practice. It would seem that this change would eliminate a strict psychophysical model. For while such difficulties as unit of PGR measurement could be solved, if the thing being studied is itself changing, this is a very different sort of phenomenon than the classical psychophysical function.

However, for that matter, 'psychophysical' types of phenomena such as visual acuity and the two-point limen on the skin change with practice (Gibson, 1953).

In the opinion of the present author, a great deal of the difficulty over 'Does the PGR correspond to consciousness' that Woodworth and Scholsberg discuss arises from the use of a classical psychophysics model on a problem where it is clearly not appropriate. The classical model more-or-less worked on those types of judgments that the S has had some experience in making such as size, distance, etc. But very few Ss sit down and ask themselves 'Just how strong is my reaction to this?'. The introspectionists did ask this question very often and when used as Ss yielded high correlations.

If Woodworth's conclusion that perhaps the closest description of the conscious correlate of the PGR is attention, several questions are raised. Should the experimenter tell S that this attention or PGR shows adaptation effects? Certainly 'expert' Ss knew this. Should the experimenter tell Ss to use the peripheral adjustments association with attention as cues? What are the effects of 'set'?

Summary

Purpose of this experiment was to study the relationship between PGR and conscious intensity. Ss were 50 randomly selected male undergraduate students. Stimuli were 50 photographs with titles. These photographs, taken from periodicals, cover a wide range of subjects. Stimuli were presented on slides, which were projected. Stimuli were divided into five series of ten stimuli each. Series were counterbalanced, the place of a slide within its series was constant. Each S had two sessions of 25 stimuli each. Testings were on successive days.

PGR was measured by means of a constant current, critically damped, Wheatstone bridge type of galvanometer, using photographic recordings.

Comparing scale values of the stimuli with the average PGRs to the stimuli, product moment correlation estimates between .18 and .25 were obtained, with these slight variations depending on the method of scaling the judgments and the unit of measurement of the PGR. By calling the first three stimuli in each series 'practice stimuli' correlation estimates of .30 to .34 were obtained. Hence, there is evidence of some sort of practice effect within a series of stimuli.

These correlation estimates are among the lowest ever reported. By analyzing other studies, it was observed: (1) That Dysinger's graduate student Ss showed better agreement than did his undergraduate Ss; (2) That most of the previous studies used graduate or professional students or trained introspectionists for Ss; and (3) In a general, 'common sense' way, the magnitude of reported correlations seems to increase with the level of psychological sophistication of the Ss used. The tentative interpretation of the low correlation figure is that it is due to the type of S used.

Correlation ratios were computed within each S for each day and for both days combined. There was a tendency for the correlation ratio to increase from the first day to the second day. There was a wide range in the correlation ratios obtained, one being as low as .05, and another being as high as .90.

The general conclusion was that some sort of learning is taking place. Since most Ss are not used to doing this sort of task, a learning or perceptual learning model would be more appropriate than the traditional approach that the variables are either related or are not related.

CHAPTER V

SOME REMARKS ON THE PGR UNIT OF MEASUREMENT PROBLEM

Introduction

It is well known that the PGR is related to the level of basic resistance, This relationship of change to basic level has been recognised as an important consideration in reference to the PGR unit of measurement problem. It is also well known that the PGRs to stimuli at the end of a list are smaller than the PGRs to the stimuli at the beginning of the series. It is also well known that the basic resistance tends to change in time, and that the basic can either increase if the subject relaxes or decrease if the subject grows more tense. (Woodworth and Schlosberg, 1954).

On the basis of evidence to be presented in this section, it seems that workers have not made sufficiently clear distinctions between these relationships, and that such distinctions are of importance to the PGR unit of measurement problem.

Problem

Many of the older studies took cognizance of the dependence of the PGR on the basic resistance to the extent that they expressed PGR in relative units; that is, change divided by level of basic resistance. Woodworth and Schlosberg, 1954).

More recently Haggard (1945, 1949) made a systematic study of the unit of measurement to be used for the PGR. He used independence of the PGR from basic resistance as a criterion of an equal interval scale. "In trying to develop an equal interval scale for the GSR, however, no such direct test is possible.... it seems necessary to take an indirect approach namely, to eliminate the variables which are known to effect a marked lack of additivity in the scale. Probably the most important variable is the strong positive relationship between the resistance level at which the GSR is recorded and the average size of the GSR." (1949, pp. 380-381).

Haggard suggested two measures that would meet this criterion. In the 1945 paper he found that the log GSR changes with the basic, and suggested log GSR + C / basic resistance as an appropriate unit of measurement. In the 1949 paper, he suggested that the log conductance change would also meet this criterion. Haggard also considered other criteria, such as the type of distribution obtained and other analysis of variance criteria.

Haggard did not consider that in using the over-all GSR basic function found in a given study, he was actually combining the relationship between the PGR and basic at a given point in the series plus the relationships between time series and GSR and changes in basic resistance over a period of time. Others have also mixed these relationships. In the 1938 edition, Woodworth stated (p. 293): " We have already spoken of a habituation effect showing as a rise in skin resistance...What we are here calling negative adaptation of PGR is the same fact, probably.". But in the 1954 edition, Woodworth and Schlosberg distinguish between changes in PGR and changes in basal resistance and regard them as different phenomena. In 1950 McCleary suggested that perhaps basal resistance level and PGR have different physiological mechanisms.

A basically different approach to the problem of PGR unit of measurement is that by Lacey (1956) who uses an <u>intraindividual</u> unit of measurement based on the deviation of a given response from the regression of the post stimulus level on the prestimulus level. Lacey insists that he consistently finds the intra-individual PGR-basic relationship to be rectilinear. He also uses this unit of measurement approach to other autonomic variables. However, this approach also has difficulties with the two variables having different time-series effects.

Dykman <u>et al</u> (1959, pp.61-62) report that in using the Lacey approach they find a lack of correspondence between the 'manifest trend' of the regression and the least square solution. The early stimuli played a disproportionate role in affecting the (least square) regression. After drawing the 'manifest trend' regression lines, the PGR (prestimulus level minus poststimulus level) still shows a strong tendency to decrease with successive stimuli. These authors also did an interindividual analysis, and again found a tendency for the PGR to decrease with successive stimuli.

This decrease of the PGR with successive stimuli as found in the study by Dykman <u>et al</u> is particularly interesting because their experimental conditions were such that the level of basic resistance was <u>increasing</u> (see graph, p. 80). That is, the usual decrease in PGR (prestimulus level minus poststimulus level) was obtained, in spite of the fact that their experimental conditions were such that the level of basic resistance was going in the opposite direction to what is obtained under usual experimental conditions.

Considering this, the conclusion of Woodworth and Schlosberg that PGR changes and changes in basic resistance are at least partly different phenomena, and the suggestion by McCleary that perhaps basic resistance level and PGR have different physiological mechanisms; the present author attempted to separate the relationship between PGR and basal resistance at a given point in a series from the changes that occur in both with time. Thus, using Haggard's criterion of independence of PGR from level of basal resistance; the relationship at a given point in a series should be considered first, and then the changes that occur in time may subsequently be considered. This analysis was done both in terms of the raw scores (ohms change) and the Haggard score (log PGR + C/ basic resistance).

Results

As seen in Figures 3 and 4, which are presented as typical examples, both the basic resistance and the PGR tended to decrease with time. This is probably the most frequently obtained result. In so far as this author knows, the increase in basic resistance quoted above has been reported only by members of the Lacey group. To the knowledge of this author, an increase in the PGR through a series has never been reported. It can be noted in these figures that a short rest tends to restore the PGR, but not the basal resistance. This is analagous to the citation by Woodworth and Schlosberg that a change in the type of stimulus tends to restore the PGR. This is one of the reasons they came to the conclusion that there is more than one variable operating.

Figure 5 presents the over-all relationship between the resistance change (metric unit that equals 22.74 ohms) and basal resistance. It can be seen that while perhaps not quite so curved as to be called logarithmic, there is a definite curvilinear relationship. Figure 6 presents the over-all relationship

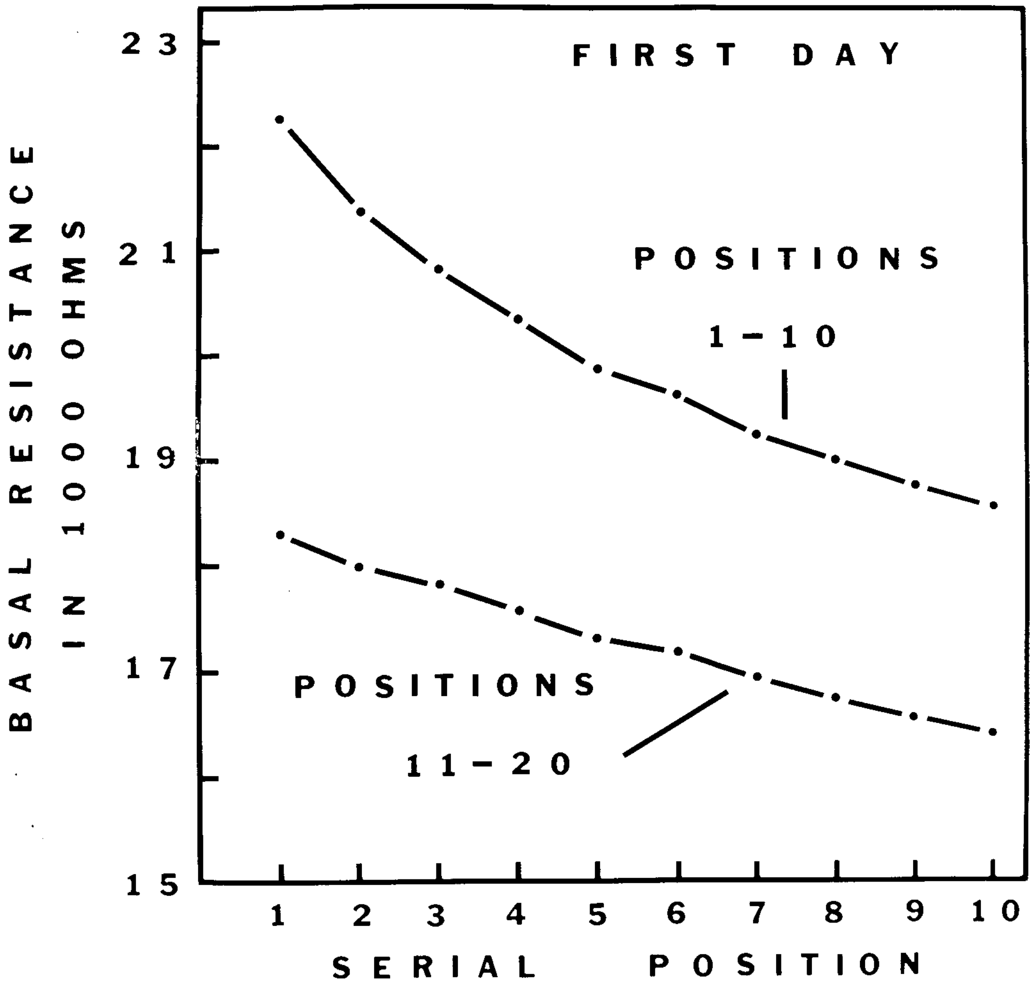
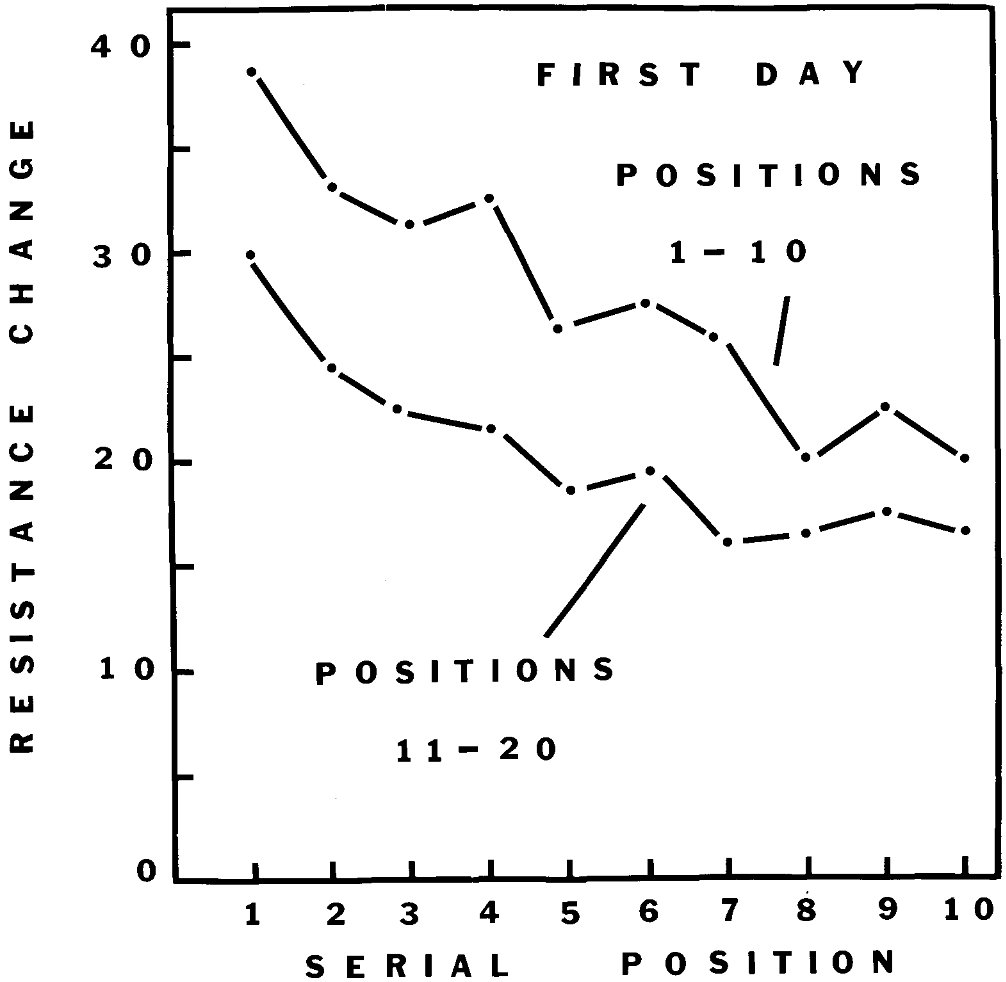


Figure 3

Basal Resistance

In 1000 Ohm Units Through

Serial Positions 1-20 for 50 Ss



Figures 4

Resistance Change

In 22.74 Ohm Units Through

Serial Positions 1-20 for 50 Ss

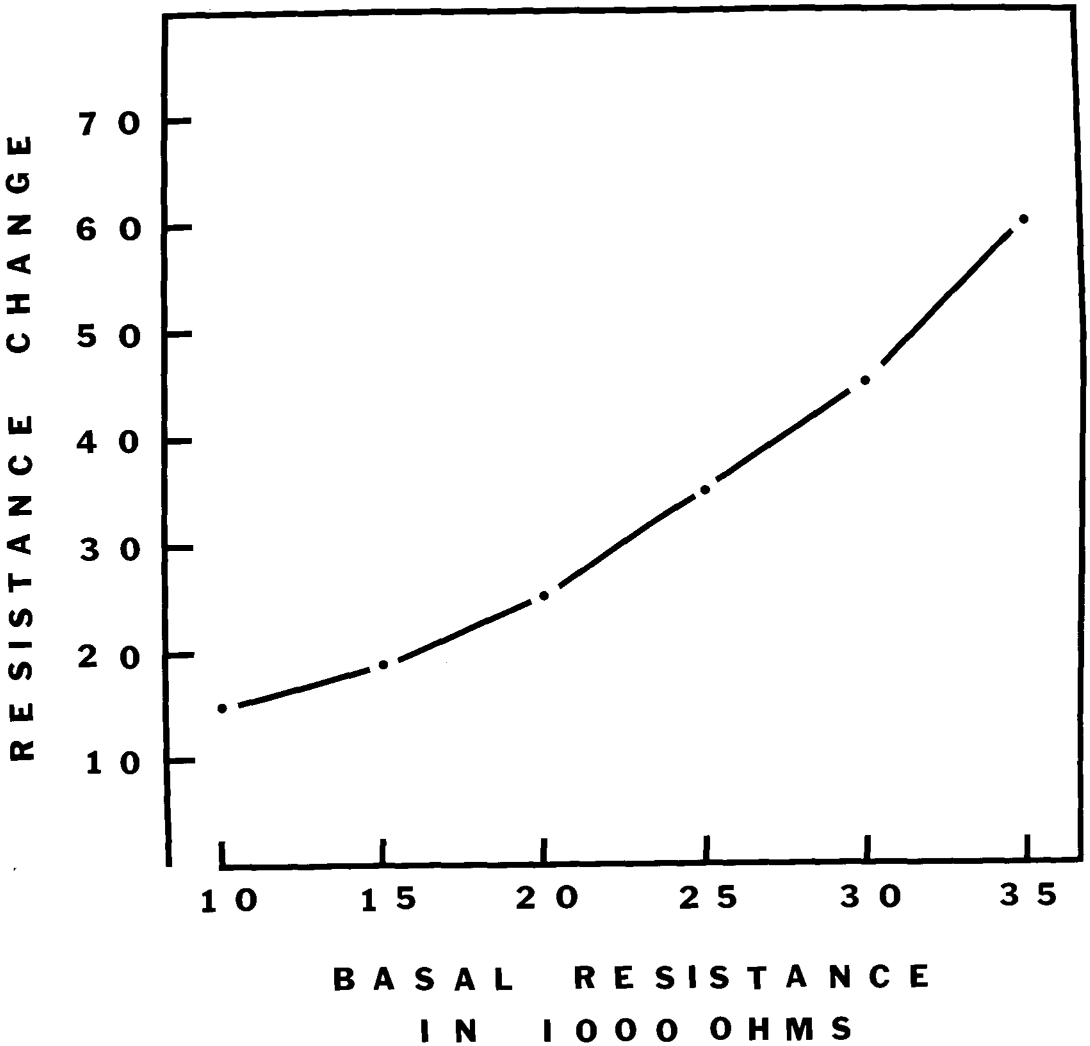


Figure 5

Resistance Change

At Various Levels of Basal

Resistance Without Regard for

Position of Stimulus Presentation

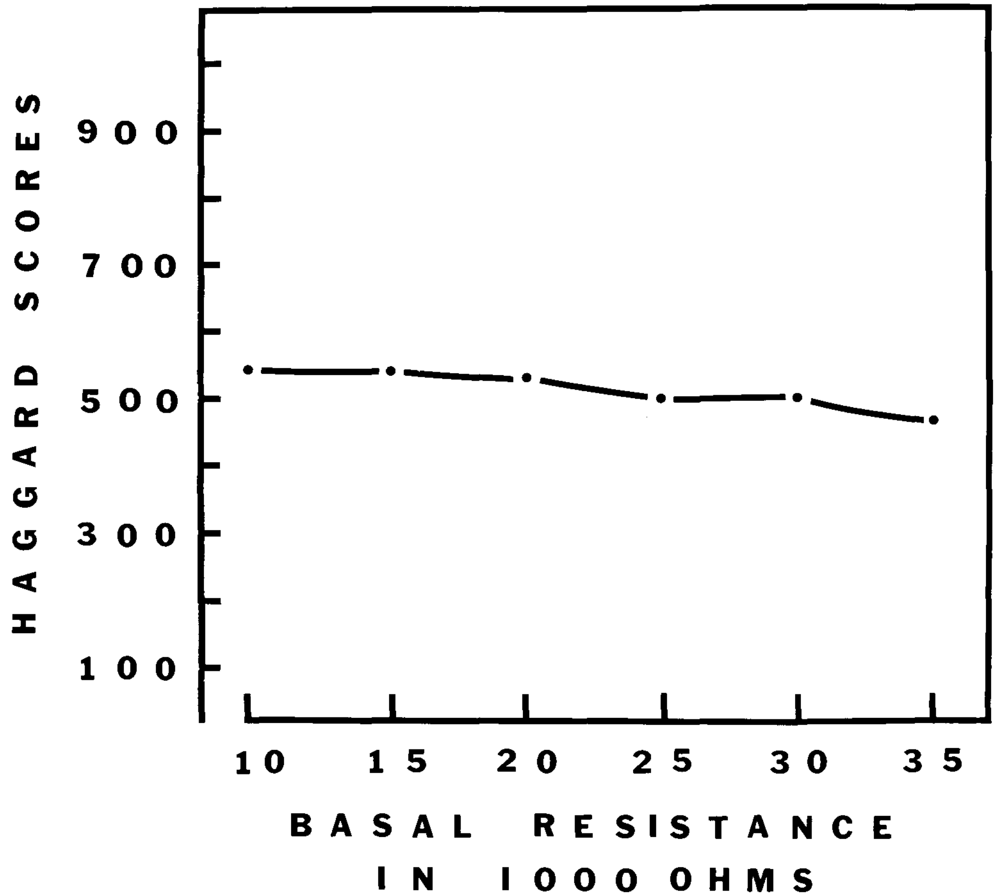


Figure 6

Haggard Score

At Various Leves of Basal

Resistance Without Regard for

Position of Stimulus Presentation

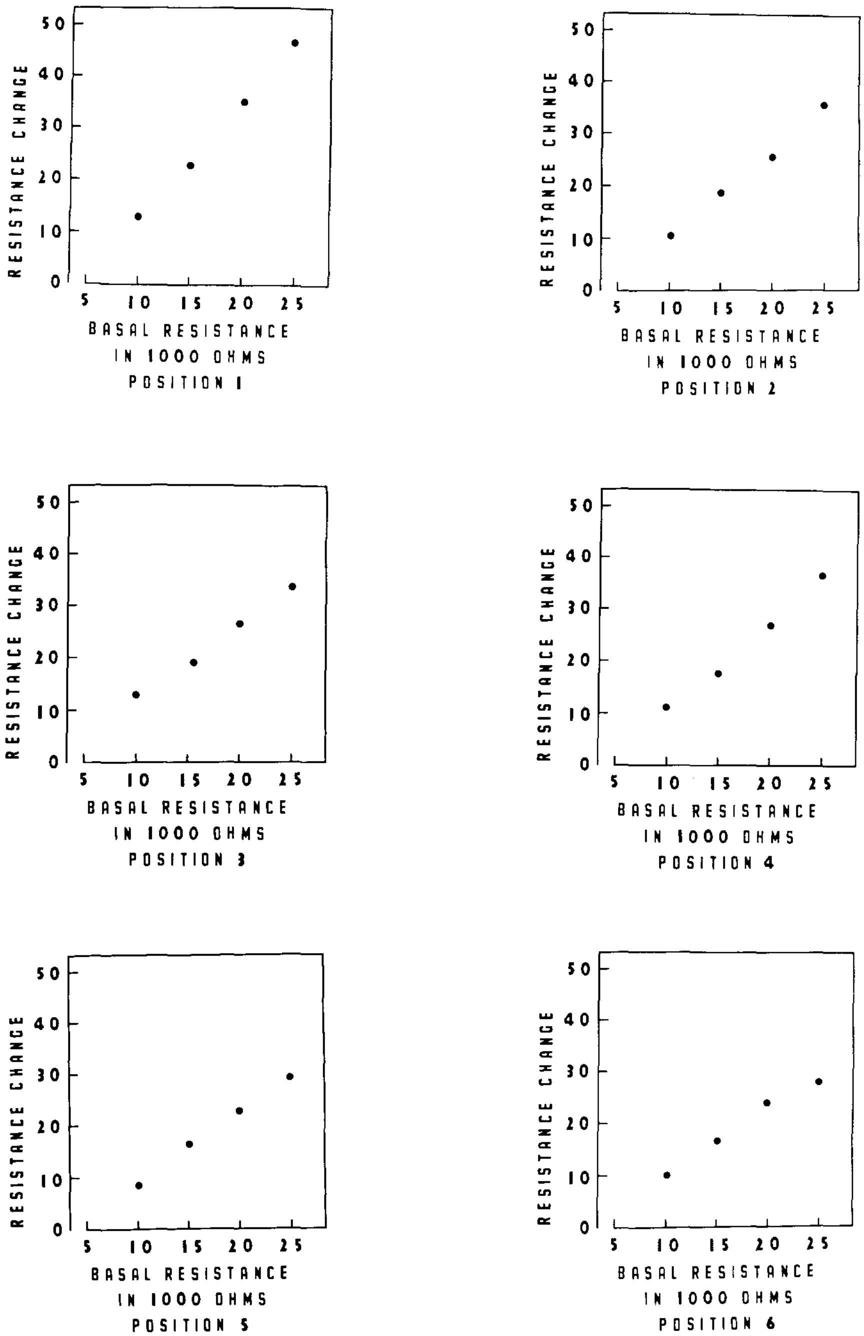


Figure 7
Resistance Change
At Various Levels of Basal Resistance
For Each of Ten Serial Positions N of 250 per Position

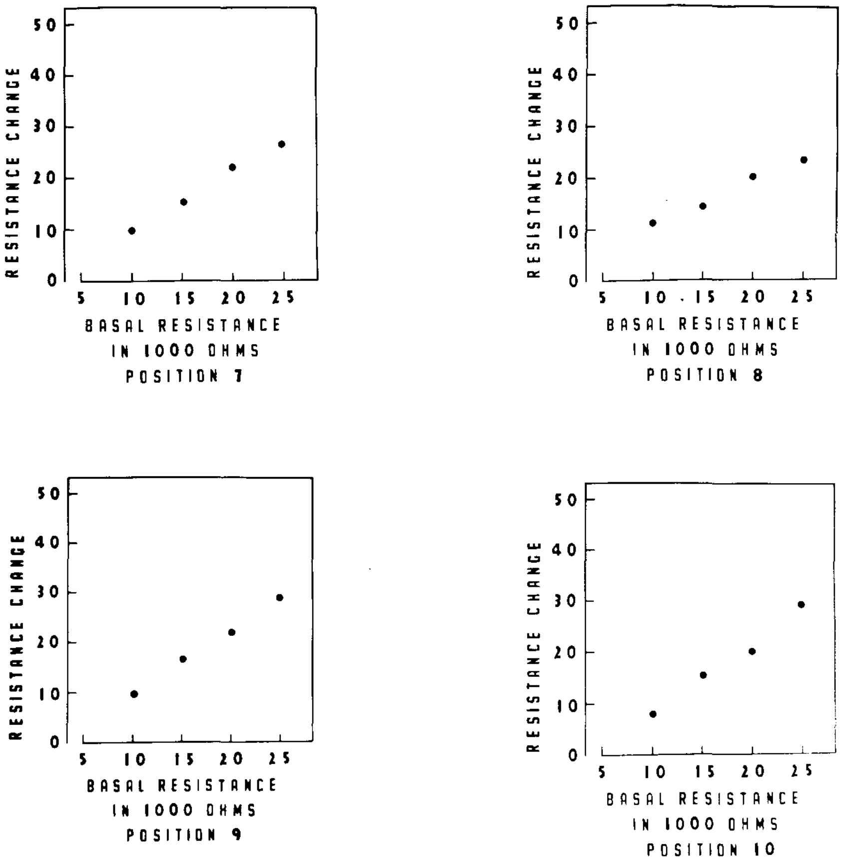


Figure 7

Resistance Change

At Various Levels of Basal Resistance

For Each of Ten Serial Positions N of 250 per Position

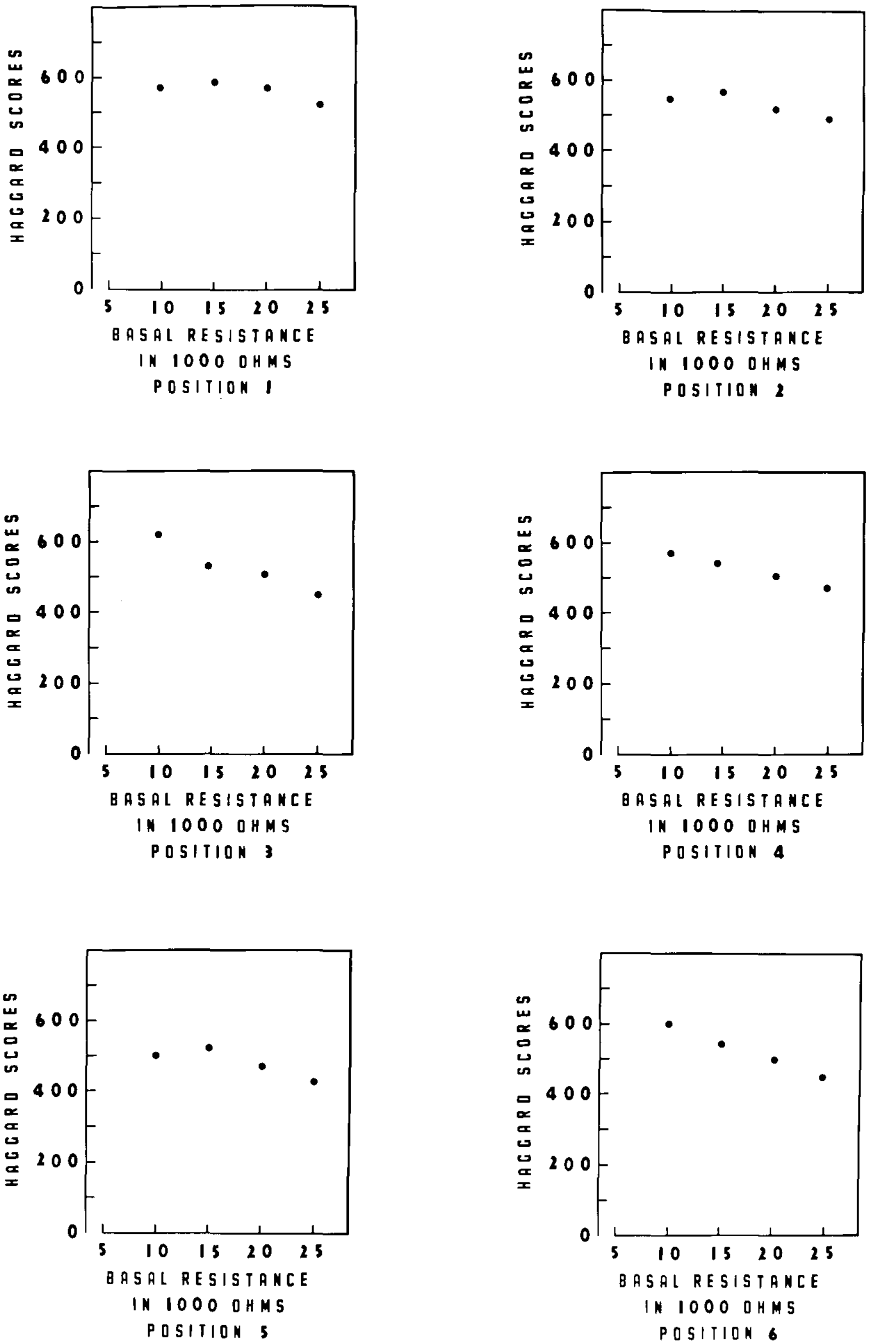


Figure 8
Haggard Scores
At Various Levels of Basal Resistance
For Each of Ten Serial Positions N of 250 per Position

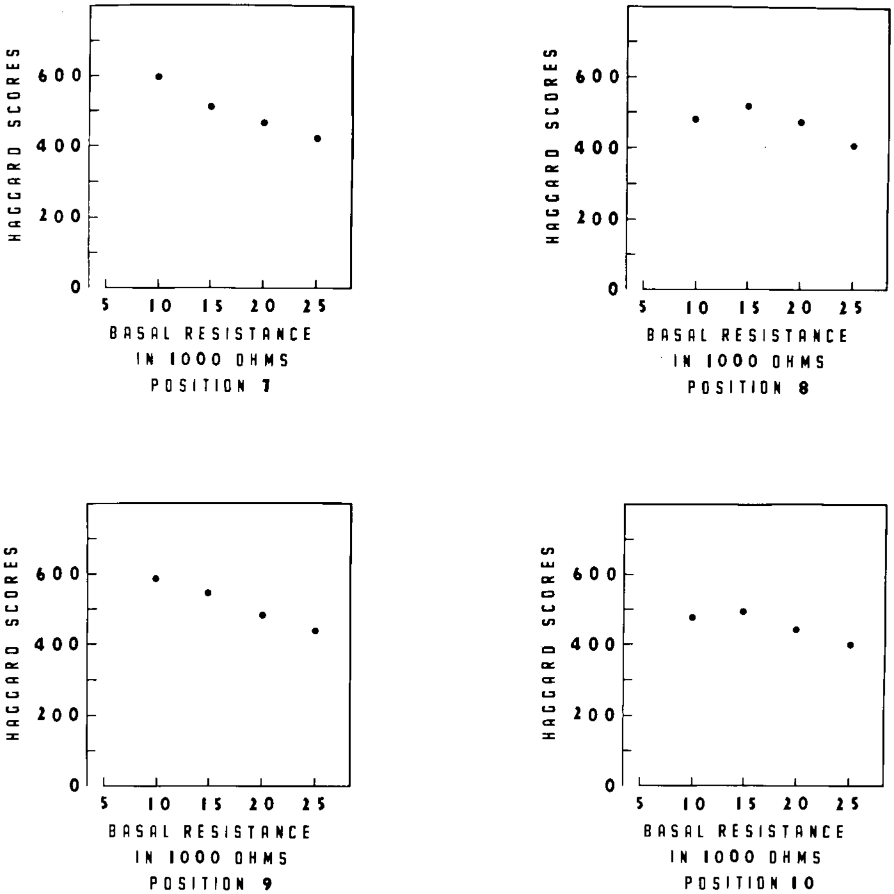


Figure 8

Haggard Scores

At Various Levels of Basal Resistance

For Each of Ten Serial Positions N of 250 Per Position

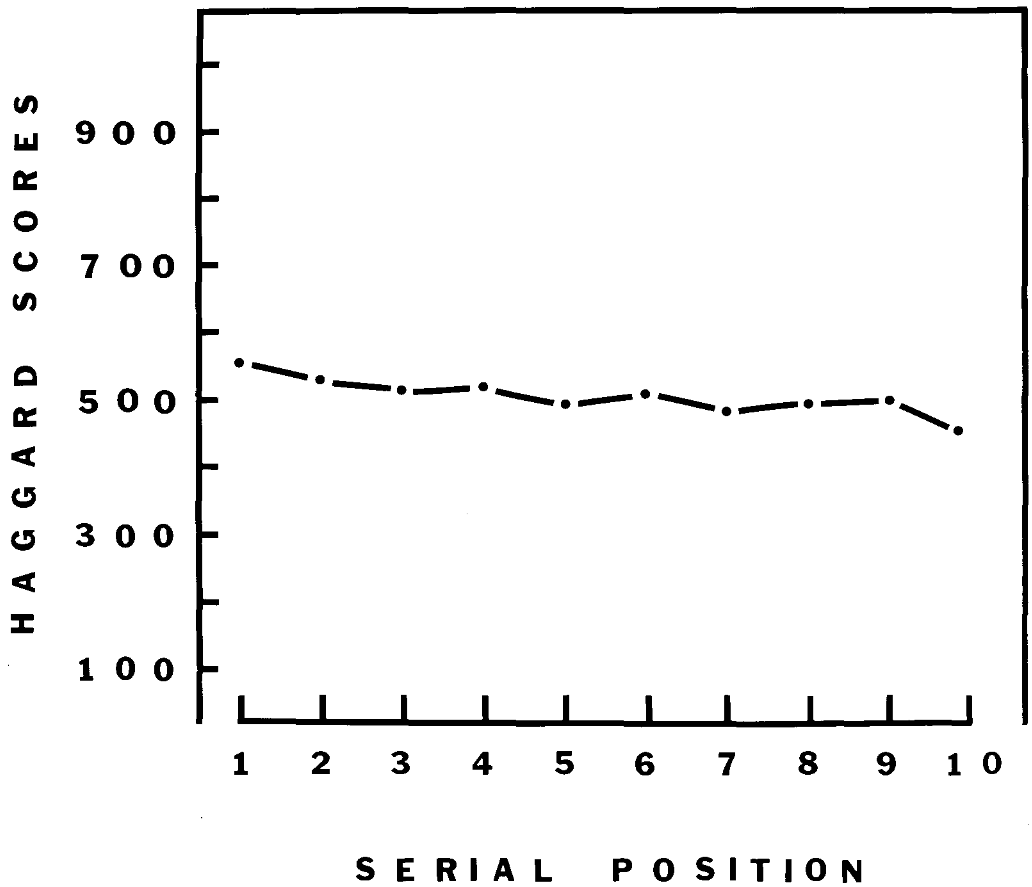


Figure 9

Haggard Score

Versus Serial Position

With Range of Haggard Scores

Corresponding to Range of Individual Scores

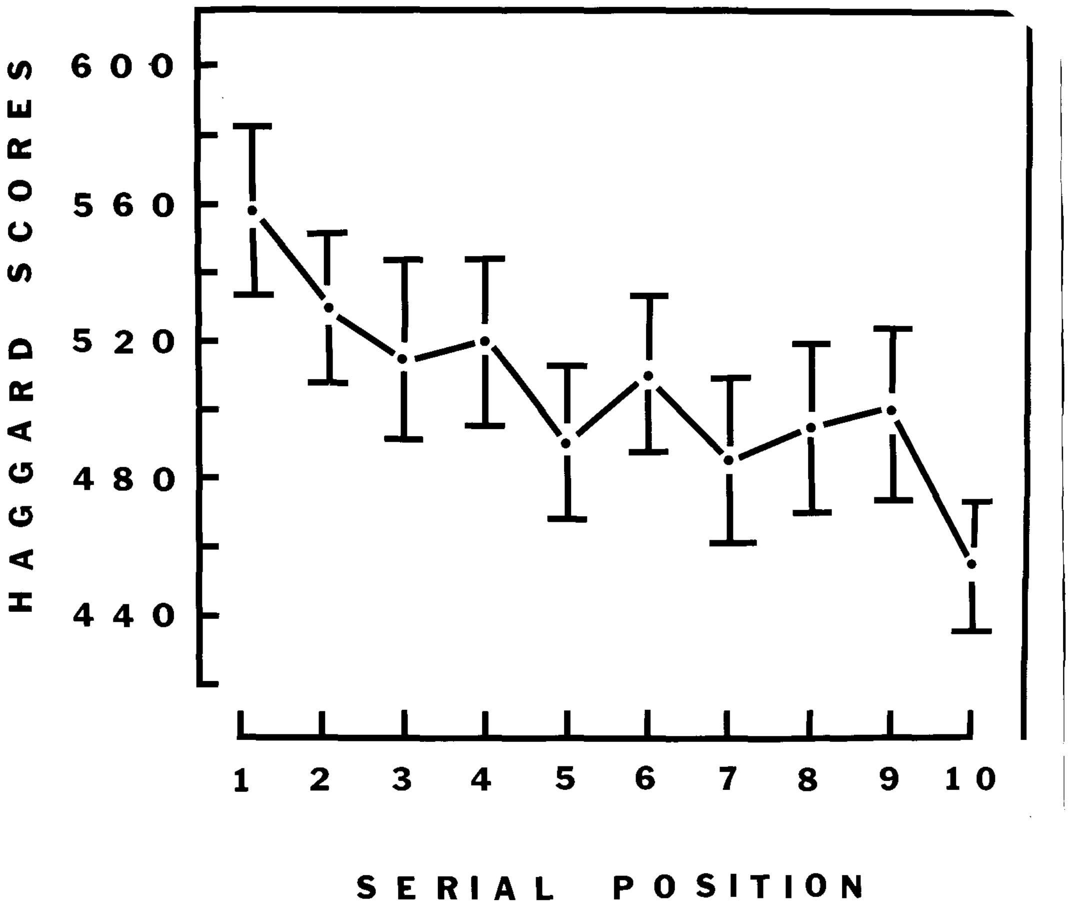


Figure 10

Haggard Score

Versus Serial Position

With Range of Haggard Scores

Corresponding to ± Two Standard Error of Means between the Haggard Score (Log PGR + C/ Basal Resistance) and the basal resistance. It can be seen that the Haggard Score does more or less correct for the over-all relationship between basic resistance and PGR. Incidentally, the Haggard Score also gave a symmetrical distribution, while the raw scores gave a positively skewed distribution. These points are made to show that, with this data, the Haggard transformation has the predicted effects.

Now if the relationship between the basic and the PGR (raw scores) within each of the ten serial positions is plotted, as in Figure 7, it is seen that the relationship is better described as rectilinear than as logarithmic. If the relationship between the basic and the Haggard Score is plotted within each of the ten serial positions, as in Figure 8, it is seen that the transformed score has over-corrected to the point where there now exists a negative relationship.

The change in the raw score PGR between serial positions is plotted in Figure 4. Now if the change in Haggard Score between serial positions is plotted, as in Figure 9, basing the height of the 'Y' axis on the absolute range of individual scores; it is seen that the transformation more or less corrects for the changes between serial positions. However, if the height of the 'Y' axis is based on the standard errors of the means of the Haggard Scores, as in Figure 10, it is seen that the Haggard transformation does not quite eliminate the change between serial positions.

Discussion

The results of this study indicate that the raw score (ohms change) is rectilinearly related to the basic resistance within each of the serial positions. There is a curvilinear decrease in raw score PGR between serial positions. The transformation considered over-corrects for the relationship within a serial position and is more or less successful in correcting for the relationship between serial positions. In this set of data, the relationship between serial positions is not quite eliminated.

Assuming that these results can be replicated, if an experimenter desires to use a PGR unit that is independent of the level of basal resistance within a serial position, he will use some rectilinear transformation. If this relationship is rectilinear; any curvilinear transformation used within a serial position will distort the relationship. Now the experimenter may or may not wish to have a PGR unit that is mathematically corrected for the changes between serial positions.

It is not to be assumed, however, that all experimenters will desire to correct for the changes between serial positions. Woodworth and Schlosberg cite several studies that have used this change as a dependent variable. In the opinion of the present writer, this may be one of the most fruitful dependent variables in the future. It is obvious that if the experimenter wishes to use the serial change as a dependent variable, he does not wish to eliminate it mathematically.

For purposes of convenience of computations, etc., the experimenter may wish to consider the shape of the distribution. It might be well here to recall the admonitions of modern textbooks in statistics to the effect that Quetelet's conception of the 'law of normality' is not correct. Blommers and Lindquist (1960) illustrate transformations into a 'normal' distribution with such examples as the economists' conversion into log dollars income or the conversion into cube roots of pounds weight.

Similarly, Woodworth and Schlosberg give several examples of PGR workers who have advocated either a log or square root transformation of PGR data in order to obtain a 'normal' distribution. At the present time, the present author knows of no logical meaning for the skewed PGR distribution which would be comparable to the meaning of a skewed distribution of dollars income or pounds weight. However, there may be some logical meaning of which we are not yet aware. Further, it certainly would not be desirable to sacrifice a meaningful dependent variable in order to obtain a 'normal' distribution.

Finally, a mathematical correction is one of several ways of handling accidental variables. In many cases, the use of control groups, counter-balancing, etc. will handle the accidental variables very nicely.

Summary

The present study considers mathematical corrections for PGR data. Within each serial position, the raw score PGR tends to be rectilinearly related to the basal resistance. If this relationship can be replicated, any curvilinear transformation applied within a serial position will tend to distort this relationship. Between serial positions, the raw score PGR tends to show a curvilinear decrease. The raw score PGR is positively skewed. One transformation was considered, the Haggard Score (log PGR + C/ Basal Resistance). Within a serial position, this transformation tends to over-correct. This transformation more or less corrects for changes between serial positions. In this set of data, the between position change was not quite eliminated.

The experimenter may or may not wish to use mathematical corrections for these relationships. Since the changes between serial positions can and have

been used as a dependent variable, there is no general solution that will fit all experimental designs. The experimenter may or may not wish to 'normalize' the distribution for convenience of computation, etc. It is not yet known whether the skewed distribution or raw PGR scores has any logical meaning. The use of mathematical corrections is one of several ways of handling accidental variables. Many times experimental controls such as control groups, counterbalancing, etc. will adequately handle the variables in question.

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APPENDIX I

PILOT STUDY STIMULI

APPENDIX II

PILOT STUDY INSTRUCTIONS

RATING SCALE

INTENSITY OF FEELINGS

NAME __________________ CLASS (Sub. & Sect.)__________ Age_____

Dear Student:

You will be shown a series of stimuli, consisting of pictures, words, or both. You are asked to look at each stimulus, and write down the first thing that comes to your mind. After this, you are asked to indicate how strong your feeling was. This will be repeated for each stimulus.

You will indicate how strong your feeling was by placing a mark (X) on a scale like this one : 1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 :. The scale runs from 1 to 9; with 1 indicating the smallest possible amount of feeling, and 9 indicating the greatest possible amount of feeling. For example, a person who checks number 2,

: 1 : X : 3 : 4 : 5 : 6 : 7 : 8 : 9 :

wants to indicate that he experienced a very small amount of feeling. The person who checks number 7,

: 1 : 2 : 3 : 4 : 5 : 6 : X : 8 : 9 :

wants to indicate that he experienced a large amount of feeling.

You are asked to make a check in the appropriate place for each stimulus. Remember that 1 indicates the smallest possible amount of feeling, and 9 indicates the greatest possible amount of feeling. Use number 1 and number 9 for the most extreme cases only. Please mark clearly, mark for each stimulus, and mark only once for each stimulus.

THANK YOU

APPENDIX III

PILOT STUDY RATING SHEET

RATING SCALE
INTENSITY OF FEELINGS

REMEMBER: A rating of 1 stands for the smallest possible intensity of feeling and a rating of 9 stands for the greatest possible amount of feeling.

PICTURES

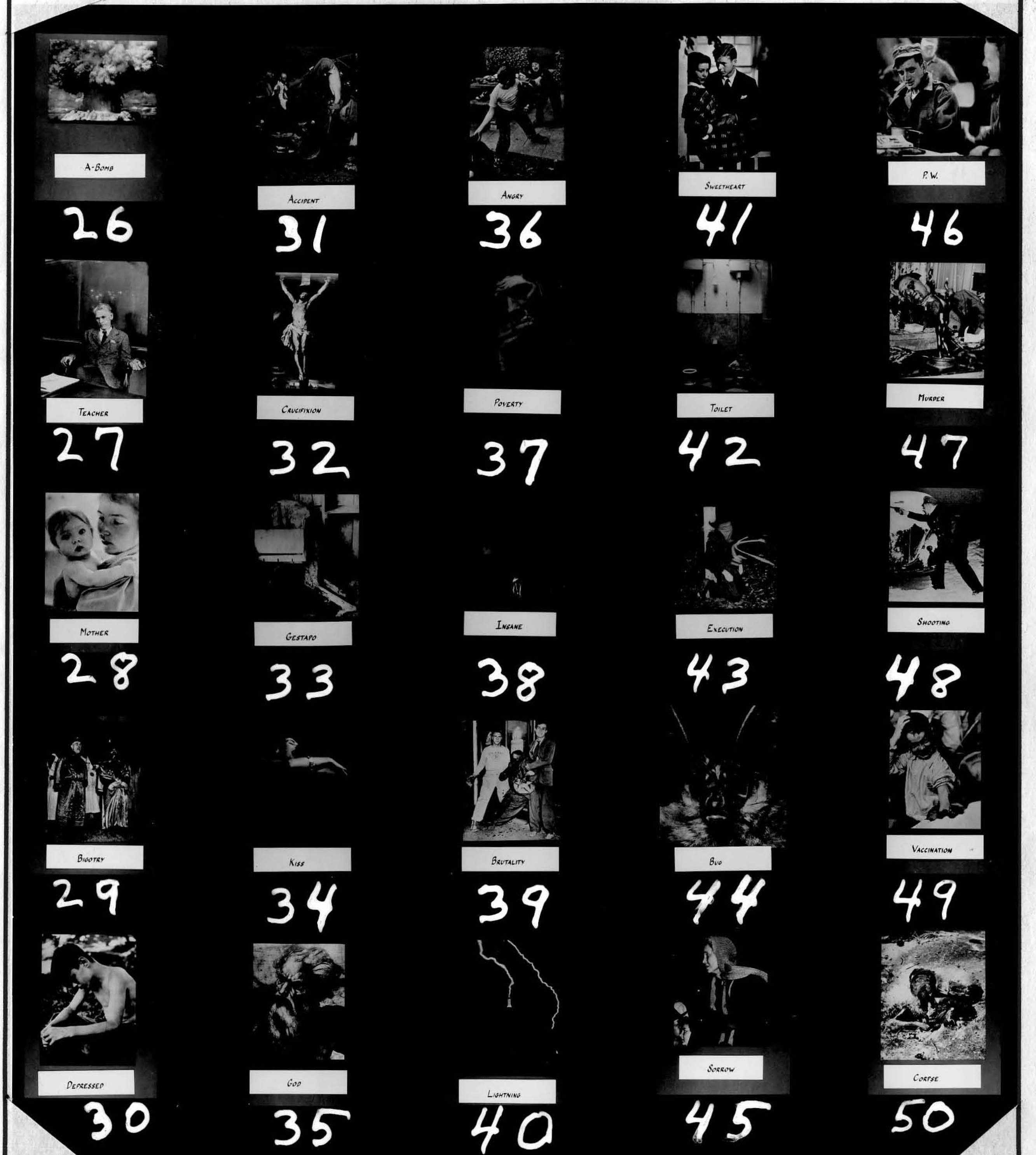
STIMULUS	ASSOCIATION	RATING 1=Smallest … 9=Greatest
No. 1		: 1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 :
No. 2		: 1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 :
No. 3		: 1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 :
No. 4		: 1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 :
No. 5		: 1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 :
No. 6		: 1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 :
No. 7		: 1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 :
No. 8		: 1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 :
No. 9		: 1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 :
No. 10		: 1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 :
No. 11		: 1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 :
No. 12		: 1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 :
No. 13		: 1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 :
No. 14		: 1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 :
No. 15		: 1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 :
No. 16		: 1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 :
No. 17		: 1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 :
No. 18		: 1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 :
No. 19		: 1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 :
No. 20		: 1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 :
No. 21		: 1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 :
No. 22		: 1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 :
No. 23		: 1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 :
No. 24		: 1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 :
No. 25		: 1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 :

APPENDIX IV

EXPERIMENTAL STIMULI

APPENDIX IV

EXPERIMENTAL STIMULI (CONTINUED)



APPENDIX V

EXPERIMENTAL INSTRUCTIONS

RATING SCALE

INTENSITY OF FEELINGS

NAME ________________________ SEX ______ AGE ____

Dear Student:

You will be shown a series of stimuli, consisting of pictures, words, or both. You are asked to look at each stimulus, and say the first thing that comes into your mind. After this, you are asked to indicate how strong your feeling was. This will be repeated for each stimulus.

You will indicate how strong your feeling was by saying a number between 1 and 9. :1:2:3:4:5:6:7:8:9:. Let 1 indicate the smallest possible amount of feeling and let 9 indicate the greatest possible amount of feeling. For example, a person who says number 2 wants to indicate that he experienced a very small amount of feeling. The person who says number 7 wants to indicate that he experienced a large amount of feeling.

You are asked to give the first thing that comes into your mind for each stimulus. Remember that 1 indicates the smallest possible amount of feeling and 9 indicates the greatest possible amount of feeling.

Now, just sit back and make yourself comfortable. After you are comfortable, please do not move around. Stay relaxed, and in the same position, until I tell you that you may change. If there is anything that is not clear, please ask before we start the experiment.

THANK YOU.

APPROVAL SHEET

The dissertation submitted by John J. Flanagan, Jr. has been read and approved by five members of the Department of Psychology.

The final copies have been examined by the director of the dissertation and the signature which appears below verifies the fact that any necessary changes have been incorporated, and that the dissertation is now given final approval with reference to content, form, and mechanical accuracy.

The dissertation is therefore accepted in partial fulfillment of the requirements for the Degree of Doctor of Philosophy.

May 23 1962
Date

[illegible]
Signature of Adviser